Functional Accessory Parathyroid Tissue in Ultimobranchial Bodies of Chickens[1] (34258)

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Surgical removal of the parathyroid glands from chickens resulted in a decrease of blood calcium within 24 hr (1–4). Although mortality following parathyroidectomy was extremely variable after operation (3), some parathyroidectomized chickens exhibited a normal blood calcium concentration by 48 hr after operation and survived many days without any evidence of hypocalcemia (2–4) and even laid eggs (1). Recovery from hypocalcemia in these cases has been attributed to an increased secretion of parathormone from accessary parathyroid tissue (1–4). Because the ultimobranchial bodies of chickens have been reported to contain nodules of tissue which were suspected of being parathyroid tissue on anatomic appearance (5–8), the experiments reported herein were designed to assess the possible role of the ultimobranchial body of the chicken as a source of functional accessory parathyroid tissue.

Materials and Methods. General. White leghorn cockerels, varying in age from 6 to 10 weeks (all cockerels of each experiment were the same age), were used in these experiments. Blood samples (1 or 2 ml) were obtained by intracardial puncture with a syringe to which a 22-gauge, 1.5 in. needle filled with a glass-distilled water solution of heparin was attached. The blood samples were centrifuged within 4 hr after collection; the plasma was transferred to separate glass containers and refrigerated until prepared for calcium determination.

Duplicate aliquots (0.25 ml) of each plasma sample were placed into separate 20-ml test tubes to which were added 0.5 ml of acidic La_2O_3 solution and 4 ml of glass-distilled water. This mixture was shaken with a mechanical device immediately after pipetting and again immediately before each calcium determination which was performed in a Perkin-Elmer flame spectrophotometer.

Surgery. Birds were anesthetized with intravenously injected sodium pentobarbital. A midline incision was made between the clavicles, and the interclavicular air sacs were ruptured to expose the region of the parathyroids and ultimobranchial bodies. All visible parathyroid glands (almost invariably four) and/or two ultimobranchial bodies were removed with forceps and blunt dissection under a dissection microscope.

Expt. 1. Twelve cockerels were placed into three groups of 4 birds each. The birds in one group were parathyroidectomized (PT-X); those in another group were PT-X and also had their ultimobranchial bodies removed (UB-X). Birds in the last group were surgically opened and their parathyroid glands and/or ultimobranchial bodies were manipulated but not removed; these birds served as sham-operated (SHAM) controls. Blood samples were obtained immediately prior to surgery and at 12, 24, and 50 hr after surgery.

Expt. 2. Eighteen cockerels were divided unequally into four groups. Birds in one group were PT-X; those in the second group were UB-X; those in the third group were PT-X + UB-X; and those in the fourth group were SHAM. Blood samples were obtained just before surgery and at 12, 24, and 48 hr after the operation. Ultimobranchial glands were fixed in Bouin solution; sections were stained with hematoxylin and eosin.

Results and Discussion. Expt. 1. As shown by the data in Fig. 1, although the plasma calcium concentration in the SHAM controls remained essentially the same, plasma calcium dropped precipitously in both the PT-X and PT-X + UB-X birds by 11 hr

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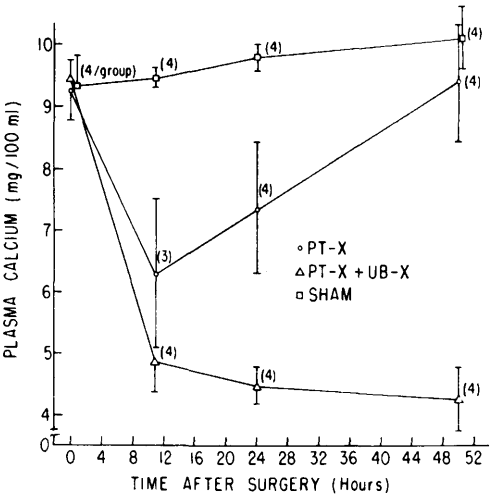

FIG. 1. Effects of PT-X and PT-X + UB-X on plasma calcium at various times after surgery. Parentheses indicate standard deviations from the mean.

after surgery; it reached a lower (not statistically significant, however) level in the PT-X + UB-X birds than in the PT-X birds. By 24 hr, the plasma calcium concentration of the PT-X birds increased above the level at 11 hr while that of the PT-X + UB-X birds remained low. At 24 hr after surgery the concentration of plasma calcium of the PT-X birds was statistically significantly greater ($p<0.005$) than that of the PT-X + UB-X birds; at 50 hr, the plasma calcium of the PT-X birds had returned to a value near that of the controls while the plasma calcium of the PT-X + UB-X birds remained at approximately half the control level.

These data show that PT-X alone resulted in a temporary decrease in plasma calcium due to removal of a source of parathormone secretion and that compensation for the loss of this source of parathormone was partially attained by 24 hr and completed by 50 hr after surgery by either cessation of production of calcitonin, a hypocalcemic factor from the ultimobranchial body (9, 10), or initiation (or increase) of production of a hypercalcemic factor from the ultimobranchial bodies which were intact. Absence of both parathyroid glands and ultimobranchial bodies allowed no recovery from the drastic drop in plasma calcium which was observed at 11 hr after operation.

Expt. 2. This experiment was conducted in an attempt to determine which of the above alternatives was responsible for the ability of the ultimobranchial bodies to compensate in returning plasma calcium concentration to a normal level following removal of the parathyroid glands. The experimental design was similar to that of Expt. 1, but included a group of birds which were UB-X only; the results are diagramed in Fig. 2. If it is assumed that the ultimobranchial bodies were releasing a hypocalcemic factor when intact, then it is reasonable to expect that plasma calcium concentration would rise after removal of the ultimobranchial bodies (parathyroid glands intact). Such an increase did not occur (Fig. 2). In fact, at 12 hr after operation, the drop in plasma calcium was equal for both the PT-X and UB-X groups. These data suggest that the ultimobranchial bodies did not cease to release a hypocalcemic factor in the absence of the parathyroid glands, but rather that the ultimobranchial

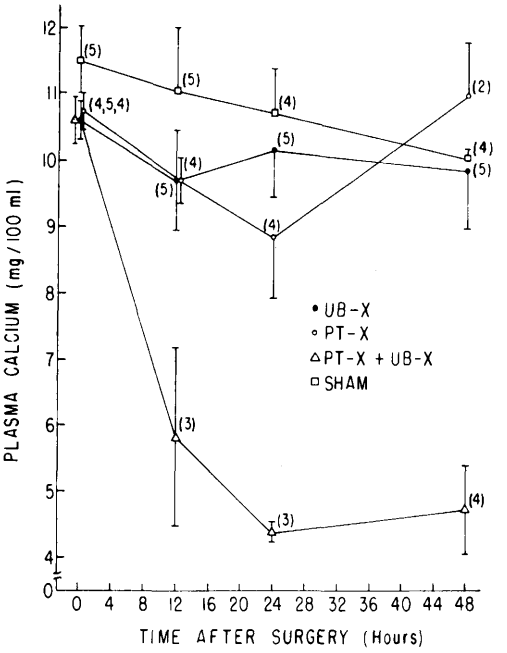

FIG. 2. Effects of PT-X, UB-X, or PT-X + UB-X on plasma calcium at various times after surgery. Parentheses indicate standard deviations from the mean.

bodies released a hypercalcemic factor. Those birds which had been PT-X had significantly higher plasma calcium levels than those birds which had been PT-X + UB-X in both Expts. 1 and 2. Furthermore, birds which had been PT-X maintained a plasma calcium level equal to that of SHAM control or UB-X birds at 48–50 hr after operation. This ability of the ultimobranchials to compensate for the parathyroids in PT-X birds would account for the fact that PT-X chickens in previous experiments reported in the literature did not uniformly die without calcium therapy.

In the present experiments, those birds which were PT-X + UB-X invariably died within 3–4 days after operation; those birds which were PT-X or UB-X lived until they were killed several weeks later for other purposes. Examination of sections of ultimobranchial bodies revealed the presence of nodules of tissue which anatomically resmbled parathyroid tissue similar to descriptions published previously (5–8).

The presence of accessory parathyroid tissue in ultimobranchial bodies of chickens as seen in birds in these experiments as well as reported by other workers (5–8) offers an explanation for the ability of the ultimobranchial bodies to compensate physiologically for the parathyroids when the latter have been surgically removed from chickens.

Summary. Plasma calcium concentrations dropped precipitously in birds whose parathyroid glands, ultimobranchial bodies, or both had been removed 11 hr previously as compared with those of sham-operated controls. By 50 hr after surgery, plasma calcium concentrations returned to near control values in PT-X + UB-X birds but remained low in PT-X + UB-X birds. These data (together with histologic evidence of parathyroid tissue within ultimobranchial bodies), constitute direct evidence for the secretion of parathormone by the accessory parathyroid tissue in the ultimobranchial bodies.

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